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Poster paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18,2006

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Many countries have started reforming their agricultural trade policies, particularly since the conclusion of the Uruguay Round of Multilateral Trade Negotiations (1986-1994). Member countries, upon the establishment of the World Trade Organization (WTO) in 1995, committed to reducing agricultural tariffs, export subsidies, and domestic support. The trade reform will inevitably have implications on producers as well as consumers. While the effects of trade reform on producers have long been the issues in the policy debates, there is relatively little attention paid to its effects on the welfare of consumers. In fact, consumer welfare is an important consideration to the importing countries for justifying their reform measures on behalf of consumers and to the exporting countries for assessing the potential of expanding foreign trade because of trade reform. To measure consumer welfare effects of trade reform, we develop a measure by approximating Hicksian compensating variation as a function of all commodity prices and compensated price elasticities. The procedure is then applied to Taiwan's meat industry and the results show substantial gain in consumer welfare and increase in demand for meats when trade reform is implemented.

Measuring Consumer Welfare: Compensating Variation

Let an initial expenditure function before trade reform be $E(p, u)$, defined as the minimum amount of expenditure necessary to get to a given level of utility u and a vector of prices p. The compensating variation (CV) to reflect the change of expenditures necessary to compensate consumers for the effects of price changes moving to price level p^* after trade reform is given by

$$CV = E(p^*, u) - E(p, u) \tag{1}$$

A positive CV implies a requirement of more spending to achieve the same utility level u after the price change from p to p^*, and thus there is a decrease in consumer welfare. On the other hand, while achieving the same utility level after the price change, a negative CV implies a drop in spending, and thus we regard it as a gain in consumer welfare.

To measure compensating variation, let $q^h(p^*, u)$ be a vector of Hicksian compensated demand at the price change from p to p^* and at the same initial utility level u. Given initial quantities demanded q, the compensating variation can be expressed as the following inner products of price and quantity vectors:

$$CV = p^* \bullet q^h(p^*, u) - p \bullet q \qquad (2)$$

By further defining $dp = p^* - p$ as a vector of price changes, and $dq^h = q^h(p^*, u) - q$ as a vector of compensated quantity changes, the above equation is transformed into

$$CV = p^* \bullet dq^h + q \bullet dp \qquad (3)$$

For empirical application, dq^h and p^* are key components in calculating the compensating variation, and their measuring procedure is explained below.

(a) How to define a vector of changes in compensated quantities demanded dq^h? We first estimate a demand system in which quantities demand is a function of prices and per capita income and obtain price elasticities (e_{ij}) and income elasticities (η_i). We then apply the Slutsky equation to derive the compensated price elasticity estimates $e_{ij}^* = e_{ij} + w_j \eta_i$, where w_j is an expenditure share. We then approximate the change in compensated demand as

$$dq_i^h / q_i = \sum_j e_{ij}^* (dp_j / p_j) \qquad (4)$$

(b) How to define the price vectors of p^*? We try to link the price changes in relation to the effect of changing tariff rates on domestic prices. In case of Taiwan's meat trade, it is a small nation facing an immense quantity supply from exporters such as the United States. By assuming that Taiwan's current rates of ad valorem tariff (say, θ) effectively block meat imports, we can calculate the implied international prices as $p^m = p/(1 + \theta)$ at domestic price level p. For a reduction of tariff rate, say δ, the new import prices would be $p^* = p^m (1 + \theta - \delta)$, which is lower than the domestic prices (p) and would dominate the domestic market. Therefore, the new price vectors can be calculated as

$$p^* = p\,[1 - \delta / (1 + \theta)] \qquad (5)$$

Effects of Trade Reform on Taiwan's Meat Industry

The developed procedure is applied to Taiwan's meat industry for evaluating the consumer welfare effects of eliminating tariff rates on meat imports. Taiwan is a good example for empirical application because Taiwan's trade regime on meat imports has substantially changed since Taiwan's accession to the WTO in 2002. Taiwan's long-term import bans on pork bellies and chicken meat was replaced by tariff rate quota (TRQ) system with an annually decreasing duty and increasing quota allowance until January 1, 2005, when TRQ restriction was replaced by ordinary tariff. However, when market prices or import volumes exceed certain "trigger" levels, imports are subject to an additional special safeguard levy permitted by WTO.

We first specify a double-log form demand system (Table 1) for allocating meat expenditures to six meat categories--pork, beef, chicken, duck, fish, and other meats. This demand system is estimated by incorporating the parametric constraints of homogeneity, symmetry, and Engel aggregation.

Table 1 --Estimated Taiwan's meat demand system

Quantity	Price of						Meat	Con-	Coef.Var
	Pork	Beef	Chicken	Duck	Fish	Other-meat	exend.	stant	(Percent)
Pork	-0.8312	0.0454	-0.0358	0.0103	-0.0893	0.0018	0.8988	4.5550	0.70
	(0.0509)	(0.0231)	(0.0258)	(0.0071)	(0.0400)	(0.0107)	(0.0292)	(0.0077)	
Beef	0.3060	-1.4018	-0.5049	-0.0171	0.0791	-0.1437	1.6824	4.2948	5.47
	(0.3506)	(0.2726)	(0.2001)	(0.0665)	(0.3309)	(0.1054)	(0.2351)	(0.0594)	
Chicken	-0.4686	-0.1137	-0.7675	-0.1913	-0.0325	0.0110	1.5626	4.6633	1.31
	(0.1103)	(0.0512)	(0.0723)	(0.0192)	(0.0867)	(0.0292)	(0.0683)	(0.0146)	
Duck	0.3466	0.0165	-0.8061	-0.1090	-0.3924	0.3625	0.5819	4.6894	1.24
	(0.1319)	(0.0774)	(0.0874)	(0.1160)	(0.1453)	(0.0741)	(0.0818)	(0.0217)	
Fish	-0.1544	0.0363	0.0806	-0.0498	-0.7333	-0.0495	0.8700	4.4209	1.74
	(0.0602)	(0.0359)	(0.0347)	(0.0140)	(0.0808)	(0.0230)	(0.0507)	(0.0159)	
Other-meat	0.0788	-0.2337	0.1871	0.5655	-0.7310	-0.7095	0.8428	4.7890	2.91
	(0.3356)	(0.1966)	(0.2103)	(0.1189)	(0.3937)	(0.2243)	(0.2299)	(0.0578)	
Expend. share	0.5104	0.0328	0.1408	0.0285	0.2694	0.0181	1.0000		

Note: Figures in parentheses are the estimated standard errors. Coef.Var (coefficient of variation) is calculated as the ratio of root-mean-square error to its sample mean of dependent variable expressed in percent.

Using these demand elasticity estimates and some basic information about domestic prices, quantities, and tariff rates for each meat category, we are able to measure the consumer welfare effects in Table 2. Case 1 is related to the welfare effects of eliminating the tariff of pork, while the tariffs of other meat categories remain the same. The tariff elimination causes a decrease in pork price by 11.11 percent. This price change would increase quantities of demand for pork by 9.24 percent and cause the quantities of all other meat categories to change simultaneously through the interdependent demand relationships. Consequently, the savings (negative of compensating variation, *CV*) on pork and other meat expenditures per person would be NT$728. This is a reduction of total meat expenditures by 6.15 percent of NT$11,836 from the base information.

Similarly, the results of cases 2 and 3 show the eliminating of tariff rates for beef and chicken, respectively, and their corresponding savings in meat expenditures for each case are NT$21 and NT$331. The results of eliminating tariff rates of all meats show that the prices would decrease

by 11 to 26 percent, and the demand for meats would increase by 11 to 26 percent. Consumers would save in meat expenditures by NT$1,796 per person, a reduction of 15.17 percent in total meat expenditures. In general, those meat categories with larger expenditure shares generate more savings under trade reform.

Table 2--Projected consumer welfare effects of eliminating tariff rates

	Pork	Beef	Chicken	Duck	Fish	Other-meat	Total
Base information (5-year average in 2000-04)							
Base price (NT$)	130.61	261.50	112.07	129.01	76.43	112.36	
Base quantity (kg)	40.19	3.39	28.14	4.20	23.81	1.65	
Base expenditure (NT$)	5249	886	3154	542	1820	185	11,836
Tariff rates (%)	12.5	16	20	35	26	23	
Case 1: Effects of eliminating the tariff of pork							
Price change (%)	-11.11	0.00	0.00	0.00	0.00	0.00	
Quantity change (%)	9.24	-3.40	5.21	-3.85	1.72	-0.88	
Savings (NT$)	390.14	114.72	115.27	38.75	58.58	10.49	728
							(6.15%)
Case 2: Effects of eliminating the tariff of beef							
Price change (%)	0.00	-13.79	0.00	0.00	0.00	0.00	
Quantity change (%)	-0.63	19.33	1.57	-0.23	-0.50	3.22	
Savings (NT$)	54.21	-19.67	-27.18	2.66	16.27	-5.27	21
							(0.18%)
Case 3: Effects of eliminating the tariff of chicken							
Price change (%)	0.00	0.00	-16.67	0.00	0.00	0.00	
Quantity change (%)	0.60	8.42	12.79	13.43	-1.34	-3.12	
Savings (NT$)	79.37	-39.60	285.80	-65.40	61.59	9.45	331
							(2.80%)
Case 4: Effects of eliminating the tariff of all meats							
Price change (%)	-11.11	-13.79	-16.67	-25.93	-20.63	-18.70	
Quantity change (%)	10.75	25.85	24.99	13.50	17.22	12.92	
Savings (NT$)	715.31	118.97	489.20	121.57	316.66	34.38	1,796
							(15.17%)

Note: Figures in parentheses of the last column are percentage of savings to total base meat expenditures of NT$ 11,836.

Consumers Gain but Effects on Farmers Need to Be Investigated

We develop a measure of consumer welfare by approximating Hicksian compensating variation as a function of all commodity prices and compensated price elasticities. The unique feature of this approach is that all direct- and cross-commodity effects of a demand system are incorporated into the welfare measurement. As shown in applying to Taiwan's meat industry, the approach is useful in measuring the consumer welfare effects of trade reform under any scenario of changes

in tariff rate tailored to specific trade policy analyses.

The welfare measurement, however, is focused only on the demand side and does not explicitly recognize the supply side of the meat markets. An extension of this research to a general demand-supply equilibrium model would be helpful for fully understanding the effects of trade reform.